C O L U M B I A R I V E R T R E A T Y

AGREEMENT

on

HYDROELECTRIC OPERATING PLAN FOR CANADIAN STORAGE

OPERATING YEAR 1975-76

The Columbia River Treaty between the United States and Canada requires that hydroelectric operating plans be agreed in advance by the Entities for the operation of the storages provided in the Treaty. The Canadian Entity and the United States Entity herewith agree that the Canadian storages will be operated in accordance with the attached "Columbia River Treaty Hydroelectric Operating Plan for Canadian Storage -- Operating Year 1975-76," dated July 1, 1970.

Ray G. Williston
Chairman
Canadian Entity

9/25/70
(Date signed)

H. R. Richmond
Chairman
United States Entity

9/23/70
(Date signed)

UNITED STATES ENTITY
COLUMBIA RIVER TREATY

P.O. Box 3621
Portland, Oregon 97208

CHAIRMAN:
Administrator,
Bonneville Power Administration
Department of The Interior

MEMBER:
Division Engineer,
North Pacific Division
Corps of Engineers
Department of the Army

Memorandum

August 21, 1970

To: Chairman, U.S. Entity
Through: Coordinators, U.S. Entity

From: Chairman, U.S. Section
Columbia River Treaty Operating Committee

Subject: Columbia River Treaty Hydroelectric Operating Plan for Canadian Storage -- 1975-76 Operating Year

The enclosed copy of the Columbia River Treaty Hydroelectric Operating Plan for Canadian Storage for the 1975-76 year, dated July 1, 1970, is hereby submitted for your review and approval. It has been agreed to by both Sections of the Columbia River Treaty Operating Committee. It complies with the requirements and stipulations in the Treaty and its associated documents.

The United States Section has consulted with the Coordination Contract Committee in accordance with Section 22 of the Pacific Northwest Coordination Contract Agreement.

The studies made to develop the plan have not included generating facilities at the Mica project. The withdrawal of storage from the Libby project was made to minimize the adverse effects on the existing International Joint Commission Order on operation of the Kootenay Lake. Changes in either of these prior to 1975-76 will require modification in the Detailed Operating Plan for 1975-76.

Chairman, U.S. Section
Columbia River Treaty Operating Committee

Enclosure

cc:
All Operating Committee Members
H. Kropitzer, Secretary, U.S. Entity

July 1, 1970

COLUMBIA RIVER TREATY
HYDROELECTRIC OPERATING PLAN
FOR
CANADIAN STORAGE

Operating Year 1975-76

TABLE OF CONTENTS

COLUMBIA RIVER TREATY
HYDROELECTRIC OPERATING PLAN
FOR
CANADIAN STORAGE

Operating Year 1975-76

INTRODUCTION

The Treaty between Canada and the United States of America relating to the cooperative development of the water resources of the Columbia River Basin requires that each year a hydroelectric operating plan be agreed by the Entities for the operation of the Columbia River Treaty storage in Canada during the sixth succeeding year. This plan will assure the entities of the manner of operation of the Canadian storage five years in advance, and is referred to herein as an Assured Operating Plan. Once adopted the Assured Operating Plans shall remain unchanged. The plan included herein has been agreed to by the Entities as the Assured Operating Plan for the 1975-76 Operating Year.

ASSURED OPERATING PLAN

1. General. The Assured Operating Plan contained herein is in keeping with requirements of the Columbia River Treaty[1/] and related documents. It also takes into account the initial filling program for the Mica project and the flood control operating plan required by the Treaty. Specifically, the Assured Operating Plan was developed in accordance with the provisions of Annexes A and B of the Columbia River Treaty, Article VII of the Protocol[2/] and Section B.1. of the Terms of Sale.[3/]

Rule curves used in the Assured Operating Plan were based on historical flows for the period July 1928 through June 1958 modified to estimated 1975-76 conditions.[7/] The Critical Rule Curve was determined from BPA

Study 76-11[9/] which was for the above-mentioned historical flow period. In this study these flows were regulated to meet the estimated Pacific Northwest system loads for the 1975-76 Operating Year. It was assumed that all reservoirs, both in the United States and Canada, were full at the beginning of the critical period. The study indicated a 42½-month critical period resulting from the adverse flows of 16 August 1928 through February 1932.

The Assured Operating Plan consists of various rule curves and operating rules whose purpose and functions are described below. Other necessary operating criteria such as initial filling programs, flood control reservoir regulation schedules and procedures for developing volume-of-inflow forecasts and refill curves are included in the Plan by reference only.

2. Operating Rule Curves. The operation of Canadian storage during the 1975-76 Operating Year shall be guided by Upper Rule Curves for the individual storages and by an Operating Rule Curve for the whole of Canadian storage. The Upper Rule Curves are firm operating constraints. They are computed in accordance with criteria given in the Flood Control Operating Plan.[5/] The Operating Rule Curve is a guide to use of storage. Draft of storage below this curve is permissable to serve firm energy loads but not secondary energy loads except when replacement of the energy is guaranteed.

The Operating Rule Curve is derived from the various curves described below. These curves are first determined for the individual Canadian storages and then summed to obtain the values for the whole of Canadian storage given by the tables included in this Plan. This is in keeping

with the provision of Article VII(2) of the Protocol. The rule curves for the individual projects totaled to obtain the composite rule curves for Canadian storage consider only usable storage. The derivation of the Operating Rule Curve is illustrated on the attached Chart.

(a) Critical Rule Curve. The Critical Rule Curve gives the end-of-month storage content of Canadian storage during the critical period. It is designed to protect the ability of the system to serve firm load with the occurrence of flows no worse than those during the most adverse historical streamflow period. A tabulation of the Composite Critical Rule Curve for the whole of Canadian storage is included as Table 1.

(b) Refill Curve. The Refill Curve is a guide to operation of Canadian storage which defines the normal limit of storage draft for secondary energy in order to provide a high probability of refilling the storage. In general, the Operating Plan does not permit serving secondary loads at the risk of refilling storages and thereby jeopardizing the firm load carrying capability of the system during subsequent years. The end of the refill period is considered to be 31 July.

The Refill Curve is, in turn, defined by two curves as discussed below.

(i) Assured Refill Curve. The Assured Refill Curve gives the end-of-month storage content required to assure refill of Canadian storage based on the second-lowest historical volume of inflow for the whole refill period and as each month of the refill period is passed the second-lowest volume for each remaining portion of the refill period. A tabulation of the composite Assured Refill Curve for the whole of Canadian storage is included as Table 2.

(ii) Variable Refill Curve. The Variable Refill Curve gives end-of-month storage contents for the period January through July required to refill Canadian storage based on forecast inflow volume during the refill period.

In carrying out the studies for the Assured Operating Plan, simulated forecasts[8/] -- such as would have been made at each date with the information then available -- were used to establish the Variable Refill Curves. Composite Variable Refill Curves for the whole of Canadian storage for all 30 years of historical record are included as Table 3 to illustrate the probable future range of these curves based on historical conditions.

(c) Upper Rule Curve. The Upper Rule Curve gives the end-of-month storage content to which each individual Canadian storage shall be evacuated for flood control and other requirements. The Upper Rule Curves used in the studies were developed from the same simulated forecasts mentioned above considering the Flood Control Storage Reservation diagrams and any other limitations. Composite Upper Rule Curves for the whole of Canadian storage for all 30 years of historical record are included as Table 4 to illustrate the probable future range of these curves based on historical conditions.

The Upper Rule Curve is based on the assumption of a transfer of two million acre-feet of flood control storage space from Arrow to Mica. This transfer will be determined each year in accordance with the Flood Control Plan and hence may not be as assumed in the studies. The composite Upper Rule Curves tabulated herein are for the sole purpose of defining the Operating Rule Curves in instances where the Upper Rule Curve provides

for greater draft than the Variable Refill Curve. In the system regulation studies, individual Upper Rule Curves for each Canadian Treaty reservoir were used as an upper limit to reservoir storage content. The tabulated values of the composite Upper Rule Curves for the refill period were taken from daily system regulation studies [6/] rather than being determined from simulated forecasts and Flood Control Storage Reservation diagrams which were used during the evacuation period.

(d) Definition of Operating Rule Curve. Prior to January 1, the Operating Rule Curve is defined by the Critical Rule Curve or the Assured Refill Curve, whichever is higher. The Critical Rule Curve for the first year of the critical period is used in the foregoing determination. Beginning January 1, the Operating Rule Curve is defined by first determining the higher of the Critical Rule Curve and the Assured Refill Curve; the Operating Rule Curve is the lower of the above-determined value or the Variable Refill Curve. At no time is the Operating Rule Curve higher than the Upper Rule Curve. Composite Operating Rule Curves for the whole of Canadian storage for all 30 years of historical record are included as Table 5 to illustrate the probable future range of these curves based on historical conditions.

3. Operating Rules. The following rules applicable to storage operation have been used in the 30-year system regulation study summarized herein to illustrate the probable range of storage operation.

(a) The whole of the Canadian storage may be drafted to its Operating Rule Curve as required to produce optimum generation in accordance with Annex A, Paragraph 6, of the Treaty, subject to project physical characteristics and operating constraints.

(b) The whole of the Canadian storage will not be drafted below its Operating Rule Curve unless:

(i) Reservoir storage in the United States system has been drafted to its Energy Content Curve; and

(ii) Deliveries of secondary energy in the United States are discontinued; and

(iii) Committed firm thermal and miscellaneous resources not displaced by surplus firm hydro resources are in operation or other replacement energy has been secured from sources other than those committed.

(c) When the conditions of (b) above are met, and it is necessary to draft additional storage to produce optimum generation as determined by the Critical Period System Regulation study, the whole of the Canadian storage and reservoir storage in the United States System will be drafted proportionately between its Operating Rule Curve or Energy Content Curve, respectively, and its Critical Rule Curve. The proportionate draft will be made first to the first year Critical Rule Curve, then between the first and second year Critical Rule Curve, the second and third year Critical Rule Curve, et cetera. When it is necessary to operate the whole of the Canadian storage and the United States reservoir storage below their lowest Critical Rule Curves, each shall be operated proportionately between its lowest Critical Rule Curve and its normal minimum content.

(d) Each individual Canadian storage will be operated on or below the storage content defined by its Upper Rule Curve.

(e) Canadian reservoirs shall be operated to provide the required flood control regulations. In the event there is a conflict between the

flood control requirements and the power requirements, the flood control requirements shall govern.

IMPLEMENTATION

The Assured Operating Plan shall be implemented in accordance with the Principles and Procedures[4/] wherein it has been agreed by the Entities that each year a Detailed Operating Plan will be prepared for the immediately succeeding Operating Year. Such Detailed Operating Plans are made under the Authority of Ariticle XIV 2.(k) of the Columbia River Treaty which states "... the powers and the duties of the entities include:

> (k) preparation and implementation of detailed operating plans that may produce results more advantageous to both countries than those that would arise from operation under the plans referred to in Annexes A and B."

The Detailed Operating Plan will reflect the latest available load, resource and other pertinent data to the extent the Entities agree these data should be included in the plan. Failing agreement on updating the Assured Operating Plan, the Detailed Operating Plan will be identical with the Assured Operating Plan prepared previously for the forthcoming Operating Year.

Beginning on 1 February 1975 the Assured Operating Plan contained herein will be reviewed and updated, as agreed by the Entities, to formulate a Detailed Operating Plan for the 1975-76 Operating Year. Actual operation during the 1975-76 Operating Year shall be guided by the Detailed Operating Plan.

The operating rules to be used in implementation of the Detailed Operating Plan are generally the same as the rules used in making the 30-year system regulation study as described in paragraph 3, Operating

Rules. The values used in the study to define the various rule curves were month-end values only. In actual day-to-day operation it is necessary to operate in such a manner during the course of each month that these month-end values can be observed in accordance with the operating rules. Because of the normal variation of power load and streamflow during any month, straight line interpolation between the month-end points should not be assumed.

During the storage drawdown season, Canadian storage should not be drafted below its month-end point at any time during the month unless it can be conservatively demonstrated that sufficient inflow is available, in excess of the minimum outflow required to serve power demand, to refill the reservoir to its end-of-month value as required. During the storage refill season, when refill of Canadian storage is being guided by Variable Refill Curves, such curves will be computed on a day-by-day basis using the residual volume-of-inflow forecasts depleted by the volume required for minimum outflow from each day through the end of the refill season.

REFERENCES

1/ Treaty between Canada and the United States of America relating to Cooperative Development of the Water Resources of the Columbia River Basin dated 17 January 1961.

2/ Protocol -- Annex to Exchange of Notes dated 22 January 1964.

3/ Terms of Sale -- Attachment to Exchange of Notes dated 22 January 1964.

4/ Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans for Canadian Treaty Storage dated 25 July 1967.

5/ Flood Control Operating Plan for Columbia River Treaty Storage dated 22 October 1968 (draft).

6/ Summary of End-of-Month Reservoir Storage Requirement for Columbia River Flood Regulation Studies 002, 003 and 004 dated 2 April 1970.

7/ Extension of Modified Flows through 1958, Water Management Subcommittee of CBIAC, dated June 1960.

8/ Volume Forecasts for Reservoir Regulation Studies, 1929-1965, Cooperative Columbia River Forecasting Unit, dated July 1967.

9/ BPA Hydroelectric Power Planning Program, 76-11 Level, 1970 Assured Operating Plan 30-Year Study, dated 3 April 1970.

TABLE 1

COLUMBIA RIVER TREATY
COMPOSITE CRITICAL RULE CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1975-76 OPERATING YEAR

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
1ST YR	7814.6	7741.9	7209.7	6485.6	5973.1	4462.3	3385.1	2215.6	2094.2	1052.2	2204.4	5217.1
2ND YR	6712.9	6409.6	5585.7	5009.5	4245.1	3115.5	2005.5	1791.3	1541.6	1602.1	2613.7	4073.3
3RD YR	4867.4	4896.1	4472.5	3930.0	3300.9	1827.9	1683.5	939.9	580.1	553.9	900.5	1842.0
4TH YR	2018.1	2039.7	1958.6	1694.6	1221.3	235.1	235.1	0.0	0.0	0.0	0.0	0.0

TABLE 2

COLUMBIA RIVER TREATY
COMPOSITE ASSURED REFILL CURVE
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1975-76 OPERATING YEAR

JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
0.0	0.0	106.2	312.1	433.1	491.8	584.2	650.3	736.0	925.0	3196.9	5733.8	7814.6

TABLE 3

COLUMBIA RIVER TREATY
COMPOSITE VARIABLE REFILL CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1975-76 OPERATING YEAR

FLOW YEAR	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
1928-29							1297.3	2125.4	2457.2	2767.6	4288.7	6674.9	7814.6
1929-30							725.5	950.5	553.2	597.8	2913.4	5733.4	"
1930-31							2011.5	2149.5	2395.5	2701.7	4341.9	7018.2	"
1931-32							394.5	293.2	0.0	7.8	2991.5	5720.0	"
1932-33							235.6	0.0	9.3	3.5	1594.1	5286.6	"
1933-34							0.0	"	1.4	29.8	713.3	5206.9	"
1934-35							"	"	0.0	0.0	726.3	4668.2	"
1935-36							914.9	719.7	1142.7	484.0	2657.0	6517.2	"
1936-37							2494.4	3023.8	2490.0	3304.5	4509.6	6605.5	"
1937-38							0.0	0.0	0.0	305.1	2258.8	5868.8	"
1938-39							619.6	508.6	108.6	707.7	3012.6	6330.1	"
1939-40							1313.9	2298.8	2242.3	2710.4	4491.9	6632.1	"
1940-41							830.2	1058.1	1517.7	2198.2	4566.3	6473.8	"
1941-42							164.4	1278.4	1967.8	2479.3	4190.4	6271.1	"
1942-43							471.4	863.0	1031.6	1313.5	3260.4	6003.0	"
1943-44							2137.6	2462.9	2737.5	2932.8	4479.5	6506.2	"
1944-45							1687.8	1797.0	1682.3	1921.8	3511.1	6430.2	"
1945-46							467.8	0.0	0.0	0.0	1375.1	5594.3	"
1946-47							271.2	35.8	16.2	239.6	2388.8	6003.8	"
1947-48							1070.2	1484.7	417.0	828.3	2166.3	5870.0	"
1948-49							1201.9	2180.6	1351.3	2077.8	3920.0	6653.7	"
1949-50							1287.7	1168.5	816.8	1112.2	2827.5	5776.9	"
1950-51							138.0	0.0	0.0	0.0	1691.1	5394.7	"
1951-52							561.6	351.6	293.4	859.7	2999.5	6294.7	"
1952-53							3585.9	1374.3	1376.8	1812.7	3275.1	6348.0	"
1953-54							1855.3	955.5	10.3	413.7	1792.9	5348.3	"
1954-55							1218.8	1671.3	1724.6	1802.4	3230.6	5697.0	"
1955-56							0.0	0.0	0.0	0.0	1529.0	5719.9	"
1956-57							83.2	49.6	"	116.2	2345.3	6547.8	"
1957-58							1351.2	1154.8	1065.6	1804.0	3580.2	6745.6	"

TABLE 4

COLUMBIA RIVER TREATY

COMPOSITE UPPER RULE CURVES

FOR THE WHOLE OF CANADIAN STORAGE

END OF MONTH CONTENTS IN KSFD

1975-76 OPERATING YEAR

FLOW
YEAR

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
1928-29	7814.6	7814.6	7814.6	7562.5	7461.7	6957.5	6342.6	6181.0	6836.6	6826.5	7067.5	7754.6	7814.6
1929-30	"	"	"	"	"	"	5959.3	5888.7	4749.4	4719.6	4632.8	5645.2	"
1930-31	"	"	"	"	"	"	6695.3	6715.6	6776.1	6736.8	7049.9	7765.7	"
1931-32	"	"	"	"	"	"	5737.4	4567.8	3554.4	3554.4	4356.6	6829.0	"
1932-33	"	"	"	"	"	"	"	"	"	"	3729.4	7318.1	"
1933-34	"	"	"	"	"	"	"	"	"	3996.0	5274.1	7477.8	"
1934-35	"	"	"	"	"	"	"	"	"	3554.4	3726.4	5853.5	"
1935-36	"	"	"	"	"	"	6781.1	5334.1	3665.3	3705.7	5889.7	7775.3	"
1936-37	"	"	"	"	"	"	6897.1	6811.4	5863.6	6067.6	6564.8	7388.1	"
1937-38	"	"	"	"	"	"	5737.4	4567.8	3554.4	3554.4	4065.7	6650.6	"
1938-39	"	"	"	"	"	"	"	4633.4	"	"	4657.5	5697.2	"
1939-40	"	"	"	"	"	"	5893.8	5853.5	3756.1	3892.2	4264.8	5813.1	"
1940-41	"	"	"	"	"	"	5737.4	4608.2	3680.5	4574.3	6351.0	7635.2	"
1941-42	"	"	"	"	"	"	"	4567.8	5072.0	5430.9	7145.6	7720.8	"
1942-43	"	"	"	"	"	"	5913.9	"	3554.4	3554.4	3901.3	5558.0	7783.4
1943-44	7783.4	"	"	"	"	"	6413.1	6690.4	6766.0	6793.3	7016.6	7729.5	7814.6
1944-45	7814.6	"	"	"	"	"	6261.8	6246.6	5661.9	4489.7	4925.7	6824.4	7806.5
1945-46	7806.5	"	"	"	"	"	5737.4	4567.8	3554.4	3565.0	4827.5	6803.3	7814.6
1946-47	7814.6	"	"	"	"	"	"	"	"	3575.1	5379.5	7697.1	"
1947-48	"	"	"	"	"	"	"	"	"	3554.4	5459.6	7738.5	"
1948-49	"	"	"	"	"	"	"	4668.7	"	3573.6	6015.2	7632.6	7813.1
1949-50	7813.1	"	"	"	"	"	5742.4	4567.8	"	3554.4	3611.9	6264.9	7814.6
1950-51	7814.6	"	"	"	"	"	5737.4	"	"	3559.5	4537.5	6405.5	"
1951-52	"	"	"	"	"	"	"	"	"	3574.6	5053.8	7071.0	"
1952-53	"	"	"	"	"	"	6892.1	4678.7	3690.5	3632.1	4008.7	7043.8	"
1953-54	"	"	"	"	"	"	5797.9	4567.8	3554.4	3554.4	4344.4	5742.6	"
1954-55	"	"	"	"	"	"	6130.8	6256.8	6045.0	4658.5	4841.1	7249.5	"
1955-56	"	"	"	"	"	6554.1	4693.8	1993.1	77.3	283.6	2232.0	5660.4	"
1956-57	"	"	"	"	"	6957.5	5747.5	4567.8	3554.4	3558.0	6836.5	7748.1	"
1957-58	"	"	"	"	"	"	5772.7	4623.3	3589.7	3584.7	5653.2	7772.8	"

TABLE 5

COLUMBIA RIVER TREATY
COMPOSITE OPERATING RULE CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1975-76 OPERATING YEAR

FLOW YEAR	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
1928-29	7814.6	7741.9	7209.7	6485.6	5973.1	4462.3	1297.3	1799.5	1932.6	1273.9	3196.9	5733.8	7814.6
1929-30	"	"	"	"	"	"	690.7	822.1	431.6	369.6	2689.3	4231.5	"
1930-31	"	"	"	"	"	"	1983.6	1797.1	1917.8	1273.9	3196.9	5733.8	"
1931-32	"	"	"	"	"	"	394.5	293.2	0.0	7.8	1641.6	5231.8	"
1932-33	"	"	"	"	"	"	235.6	0.0	9.3	3.5	1499.4	5286.6	"
1933-34	"	"	"	"	"	"	0.0	"	1.4	29.8	642.3	5162.6	"
1934-35	"	"	"	"	"	"	"	"	0.0	0.0	726.3	3898.6	"
1935-36	"	"	"	"	"	"	914.9	719.7	1007.6	477.1	2627.2	5733.8	"
1936-37	"	"	"	"	"	"	2071.1	2180.0	1836.5	1273.9	3196.9	"	"
1937-38	"	"	"	"	"	"	0.0	0.0	0.0	305.1	1444.8	4905.9	"
1938-39	"	"	"	"	"	"	619.6	508.6	108.6	682.9	1872.3	4343.9	"
1939-40	"	"	"	"	"	"	1313.9	1725.4	1605.7	1269.8	2410.3	4577.2	"
1940-41	"	"	"	"	"	"	830.2	1014.9	1278.6	1004.4	3196.9	5619.1	"
1941-42	"	"	"	"	"	"	164.4	1224.5	1577.1	1232.3	3144.1	5453.4	"
1942-43	"	"	"	"	"	"	471.4	863.0	1013.7	765.1	1941.4	4088.1	7783.4
1943-44	7783.4	"	"	"	"	"	2000.3	1872.7	1920.0	1273.9	3196.9	5636.5	7814.6
1944-45	7814.6	"	"	"	"	"	1670.3	1772.4	1663.6	1249.0	3019.1	5626.4	7806.5
1945-46	7806.5	"	"	"	"	"	467.8	0.0	0.0	0.0	1375.1	5097.5	7814.6
1946-47	7814.6	"	"	"	"	"	271.2	35.8	16.2	223.5	2388.8	5502.4	"
1947-48	"	"	"	"	"	"	1070.2	1459.5	417.0	818.7	2166.3	5453.2	"
1948-49	"	"	"	"	"	"	1201.9	2010.7	1326.0	1202.6	3194.3	5733.8	7813.1
1949-50	7813.1	"	"	"	"	"	1287.7	1105.7	753.9	912.0	1884.5	4760.0	7814.6
1950-51	7814.6	"	"	"	"	"	138.0	0.0	0.0	0.0	1675.1	4673.8	"
1951-52	"	"	"	"	"	"	561.6	351.6	293.4	793.1	2626.7	5575.7	"
1952-53	"	"	"	"	"	"	2980.1	1276.3	1286.6	1261.1	2192.2	5620.2	"
1953-54	"	"	"	"	"	"	1749.9	932.8	10.3	413.7	1612.2	3978.1	"
1954-55	"	"	"	"	"	"	1210.1	1584.9	1645.0	1273.9	2913.1	5300.5	"
1955-56	"	"	"	"	"	"	0.0	0.0	0.0	0.0	1529.0	5302.5	"
1956-57	"	"	"	"	"	"	83.2	42.3	"	116.2	2345.3	5729.3	"
1957-58	"	"	"	"	"	"	1351.2	1078.1	999.5	1137.6	3058.7	5733.8	"

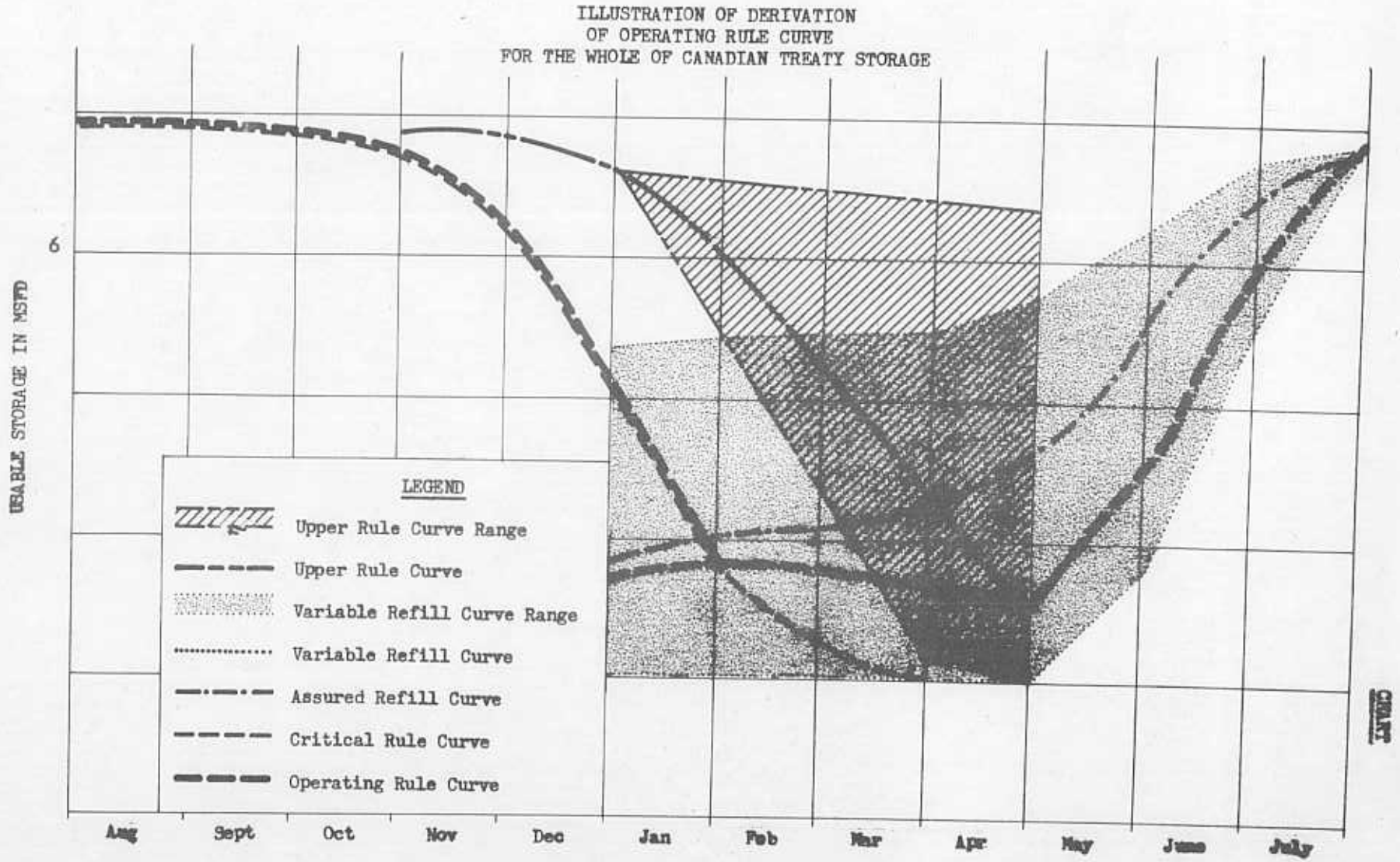


ILLUSTRATION OF DERIVATION
OF OPERATING RULE CURVE
FOR THE WHOLE OF CANADIAN TREATY STORAGE
USABLE STORAGE IN MSFD
6
LEGEND
Upper Rule Curve Range
Upper Rule Curve
Variable Refill Curve Range
Variable Refill Curve
Assured Refill Curve
Critical Rule Curve
Operating Rule Curve
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
July
CHART

COLUMBIA RIVER TREATY

AGREEMENT

on

DETERMINATION OF DOWNSTREAM POWER BENEFITS

RESULTING FROM CANADIAN STORAGE

FOR OPERATING YEAR 1975-76

The Columbia River Treaty between Canada and the United States requires that the downstream power benefits resulting from operating plans agreed to by the Entities will be determined in advance by the Entities. The determination of downstream power benefits for the operating year 1975-76 is covered in the attached report, dated June 30, 1970, and is agreed to by the United States Entity and the Canadian Entity.

Ray G. Williston
Chairman
Canadian Entity

9/25/70
(Date signed)

H. R. Richmond
Chairman
United States Entity

9/23/70
(Date signed)

UNITED STATES ENTITY

COLUMBIA RIVER TREATY

P.O. Box 3621

Portland, Oregon 97208

CHAIRMAN:
Administrator,
Bonneville Power Administration
Department of The Interior

MEMBER:
Division Engineer,
North Pacific Division
Corps of Engineers
Department of the Army

August 21, 1970

Memorandum

To: Chairman, U.S. Entity
Through: Coordinators, U.S. Entity

From: Chairman, U.S. Section
Columbia River Treaty Operating Committee

Subject: Determination of Downstream Benefits Resulting from Canadian Treaty Storage for Operating Year 1975-76

The Columbia River Treaty Operating Committee has prepared the enclosed document dated June 30, 1970, in accordance with the requirements of the Treaty. The United States Section of the Operating Committee recommends its adoption and approval by the United States Entity. A similar recommendation is being made by the Canadian Section.

Chairman, U.S. Section
Columbia River Treaty Operating Committee

Enclosure

cc:
All Operating Committee Members
H. Kropitzer, Secretary, U.S. Entity

DETERMINATION OF DOWNSTREAM POWER BENEFITS RESULTING FROM CANADIAN STORAGE FOR OPERATING YEAR 1975-76

June 30, 1970

I. Introduction.

The Treaty between Canada and the United States of America and related documents relating to the cooperative development of the water resources of the Columbia River Basin requires that downstream power benefits from Canadian storage be determined in advance by the two entities. The purpose of this report is to set out the results of downstream power benefit computations for the sixth succeeding year, 1975-76, and for the storages for which the Assured Operating Plan was developed.

The procedures followed in the benefit studies are those provided in Annex B of the Treaty, in Articles VIII, IX, and X of the Protocol and in the document, "Procedures for the Determination of Downstream Power Benefits Resulting from Canadian Storage," dated September 9, 1968.

II. Results of Study.

The Canadian Entitlement, which is one-half the total computed downstream power benefits, was computed to be:

Dependable Capacity = 1,480 mw

Average Annual Energy = 668 mw

III. Computation of Entitlement.

The following Tables and Charts are attached and summarize the study:

Table 1. Computation of Canadian Entitlement

The essential elements used in the computation of the Canadian Entitlement as provided in Paragraphs 2 and 3 of Annex B are shown in this table.

Table 2. Summary of Power Regulations for the Computation of Canadian Entitlement of Downstream Benefits

This table summarizes the Step 1, 2, and 3 regulations by projects.

Table 3. Determination of Load Shape for Steps 2 and 3, Canadian Entitlement Computation

The load shape for Steps 2 and 3 carry the same ratio between each month and the annual average as does the Pacific Northwest area load. The Northwest area firm loads on this table were based on the current forecast data. The Grand Coulee pumping load is also included in this estimate.

The firm load for Steps 2 and 3 is computed as follows:

(1) Estimate the hydro nominal prime power for the critical period;

(2) Add the thermal from Step 1 less reserve;

(3) Multiply (2) by the ratio of the area annual average firm load to the area critical period firm load to obtain the annual average firm load for Steps 2 or 3 (the ratios used in this study were 0.99115 and 0.97008, respectively);

(4) Pro rate the average annual Step 2 or 3 load determined in (3) by months in the ratio that each monthly area load bears to the annual average area load; and

(5) Subtract the thermal in each month to obtain the monthly firm hydro load. The average annual hydro load for Steps 2 and 3 also becomes the firm energy considered usable according to Annex B, Paragraph 3(a).

Chart 1 & 2. Secondary Energy Duration Curve, Steps 2 and 3

These charts are duration curves of the secondary energy for Steps 2 and 3. The secondary energy is the capability each month which exceeds the firm hydro loads shown in Table 3. The usable secondary energy shown in average megawatts for each step is computed in accordance with Annex B, Paragraphs 3 (b) and 3 (c). The "other usable secondary" was computed on the basis of 40% of the remainder after thermal replacement. The thermal replacement was limited to the existing and scheduled thermal energy capability after allowance for reserve, except when an energy surplus condition occurs; then the thermal replacement must not exceed the total of the thermal energy capability and the estimated interruptible load.

Thermal Energy Capability - mw	4,064
Less 5% Reserves - mw	203
Thermal Replacement - mw	3,861

The following tabulation shows the ordinate values for usable secondary energy:

	Step 2	Step 3
Thermal Replacement	3,861	3,861
Other	1,218	1,982
Total - mw	5,079	5,843

TABLE 1

COMPUTATION OF CANADIAN ENTITLEMENT

Generation Figures are in Average Megawatts; Load Factors, in Percent

Determination of Dependable Capacity Credited to Canadian Storage

Critical Period Average Rate of Generation with Canadian Storage, Step 2. . .	8,963
Critical Period Average Rate of Generation without Canadian Storage, Step 3 .	6,898
Gain Due to Canadian Storage.	2,065
Estimated Average Critical Period Load Factor - Percent	69.782
Dependable Capacity Gain 1/	2,959
Canadian Share of Dependable Capacity	1,480

Determination of Increase in Average Annual Usable Energy

Step 2 (with Canadian Storage)

Annual Firm Hydro Energy.	8,850
Thermal Replacement Energy.	1,685
Other Usable Secondary Energy	254
System Annual Average Usable Energy	10,789

Step 3 (without Canadian Storage)

Annual Firm Hydro Energy.	6,576
Thermal Replacement Energy.	2,268
Other Usable Secondary Energy	609
System Annual Average Usable Energy	9,453

Average Annual Usable Energy Gain	1,336
Canadian Share of Average Annual Energy Gain.	668

1/ Dependable capacity gain credited to Canadian storage equals gain in critical period average rate of generation divided by the estimated average critical period load factor.

SUMMARY OF POWER REGULATIONS FOR 1975-76
FOR THE COMPUTATIONS OF CANADIAN ENTITLEMENT
TO DOWNSTREAM BENEFITS

TABLE 2

PROJECTS:	BASIC DATA		STEP 1			STEP 2				STEP 3			
	Number of Units	Nominal Installed Peaking Capacity mw	Usable Storage 1000 AF	January Peaking Capability mw	Critical Period Average Generation mw	Usable Storage 1000 AF	January Peaking Capability mw	Critical Period Average Generation mw	Average Annual Generation mw	Usable Storage 1000 AF	January Peaking Capability mw	Critical Period Average Generation mw	Average Annual Generation mw
CANADIAN													
Mica			7,008			7,008							
Arrow			7,145			7,145							
Duncan			1,347			1,347							
Subtotal			15,500			15,500							
BASE SYSTEM FEDERAL													
Hungry Horse	4	328	3,161	160	102	3,008	198	113	101	3,008	278	212	101
Albeni Falls	3	49	1,155	25	23	1,155	22	22	22	1,155	23	25	24
Grand Coulee	21+2	4,240	5,232	3,965	1,942	5,072	4,181	1,766	2,280	5,072	3,951	1,228	2,094
Chief Joseph	16-19	1,389		1,389	1,083		1,389	1,003	1,196		1,389	705	1,077
Ice Harbor	6	693		693	220		693	326	305		693	171	305
McNary	14	1,127		1,127	648		1,127	594	762		1,127	429	713
John Day	16	2,484	535	2,484	922		2,484	928	1,270		2,484	678	1,234
The Dalles	22	2,013		2,015	768		2,015	740	1,015		2,015	519	980
Bonneville	10	574		574	544		574	534	535		574	426	511
Subtotal		12,899	10,083	12,432	6,252	9,235	12,683	5,926	7,486	9,235	12,534	4,393	7,039
BASE SYSTEM NON-FEDERAL													
Kootenay Lake (Canadian)			787			427				427			
Kerr	3	185	1,219	170	114	1,219	176	104	123	1,219	179	131	122
Thompson Falls	6	40		40	35		39	37	32		38	37	31
Noxon Rapids	4	430	231	421	173		430	160	218		430	179	218
Cabinet Gorge	4	230		230	111		230	99	129		230	111	129
Box Canyon	4	71		71	47		71	45	51		71	52	49
Coeur d'Alene & Long Lake			327			223				223			
Wells	10	820		820	439		820	411	514		820	287	474
Chelan	2	54	677	50	38	676	51	38	46	676	52	49	45
Rocky Reach	11	1,291		1,291	645		1,291	607	768		1,291	426	717
Rock Island	10	159		157	155		157	156	150		138	124	140
Wanapum	10	986		986	559		986	525	657		986	365	599
Priest Rapids	10	912		912	528		912	496	618		912	356	565
Brownlee	4	450	980	376	205	974	450	247	259	974	450	253	254
Oxbow	4	220		220	95		220	112	119		220	115	120
Subtotal		5,848	4,221	5,744	3,144	3,319	5,833	3,037	3,684	3,319	5,837	2,505	3,483
TOTAL BASE SYSTEM HYDRO		18,747	29,804	18,176	9,396	28,254	18,516	8,963	11,170	12,754	18,371	6,898	10,502
ADDITIONAL STEP 1 PROJECTS													
Libby	4	483	4,965	189	203								
Boundary	4	630		650	360								
Spokane River Plants		153		147	89								
Hells Canyon	3	450		450	180								
Dworshak	3	460	2,000	414	172								
Lewiston	2	6		6	6								
Lower Granite	2-3	466		466	218								
Little Goose	3	466		466	214								
Lower Monumental	3	466		466	218								
Felton and Round Butte		454	274	423	132								
Subtotal		4,054	7,239	3,677	1,792								
Independent Resources		4,652	8,439	3,781	1,719								
TOTAL HYDRO RESOURCES		27,453	45,482	25,634	12,907								
THERMAL RESOURCES													
NPR 1/				839	633								
OTHERS 1/				452	281								
Centralia #1 & #2				1,400	1,260								
Trojan				1,100	990								
Nine Mile #1 & #2				1,000	900								
TOTAL THERMAL RESOURCES				4,791	4,064								
TOTAL IMPORTS				70	409								
TOTAL RESOURCES (HYDRO & THERMAL)				30,495	17,380								
RESERVES 2/				-2,085	-203								
RESOURCES AVAILABLE FOR LOAD				28,410	17,177								
ESTIMATED LOAD													
Pacific Northwest Area				26,063	16,517								
SYSTEM LOAD				26,063	16,517								
SURPLUS OR (DEFICIT)				2,347	660								
CRITICAL PERIOD													
Starts :				August 16, 1928			September 1943				September 16, 1936		
Ends :				February 1932			April 1945				April 15, 1937		
Length (Months):				42-1/2 Months			20 Months				7 Months		
STUDY IDENTIFICATION				76-11			76-12				76-13		

1/ Includes 839 mw peak and 633 mw energy from NPR under single purpose operation, 398 mw peak and 265 mw energy from existing thermal plants, and 54 mw peak and 16 mw energy from miscellaneous contracts.

2/ Peak reserves are 6% of peak load; energy reserves are 5% of thermal plant energy capability not including NPR.

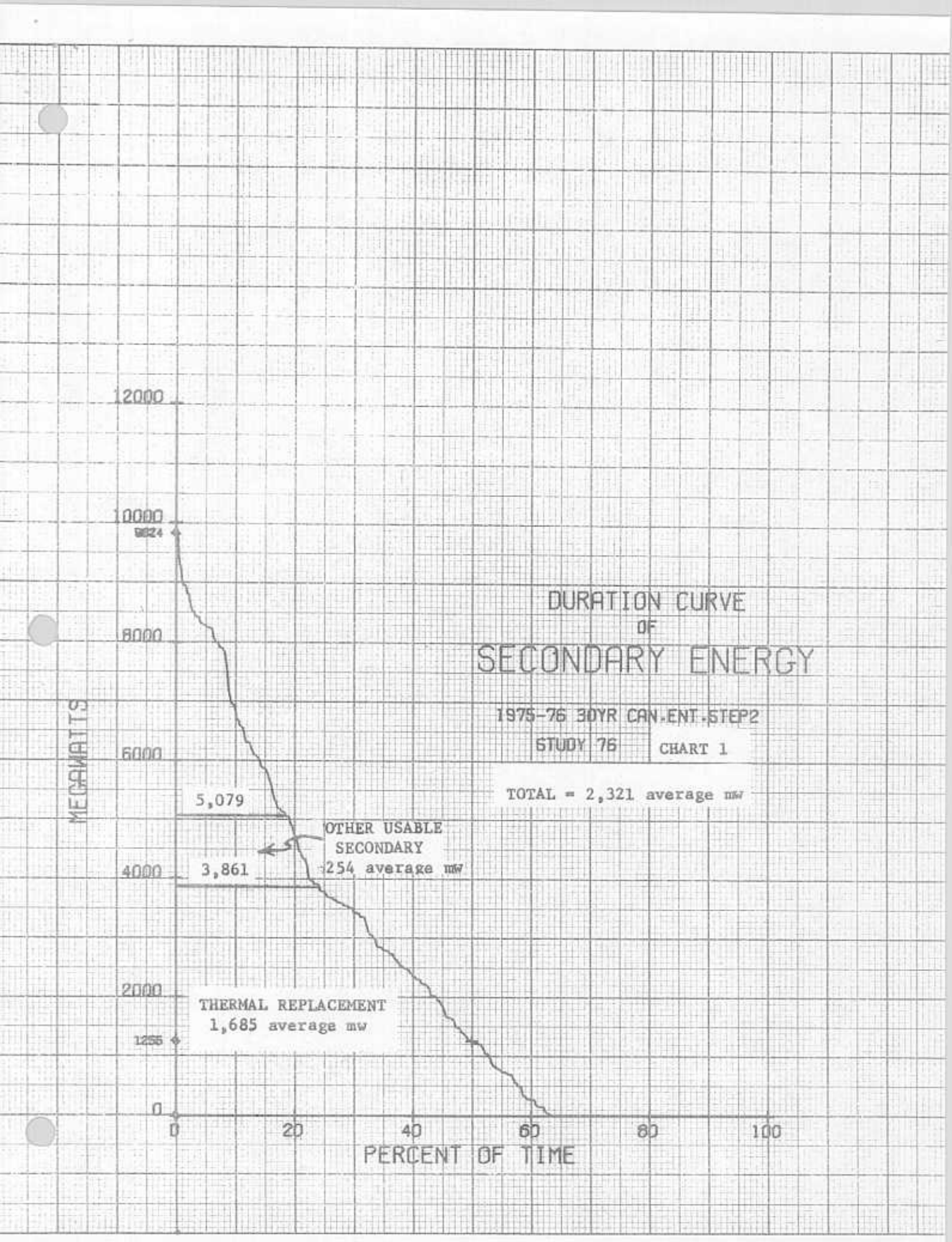
Determination of Load Shape for Steps 2 and 3
1975-76 Canadian Entitlement Computations

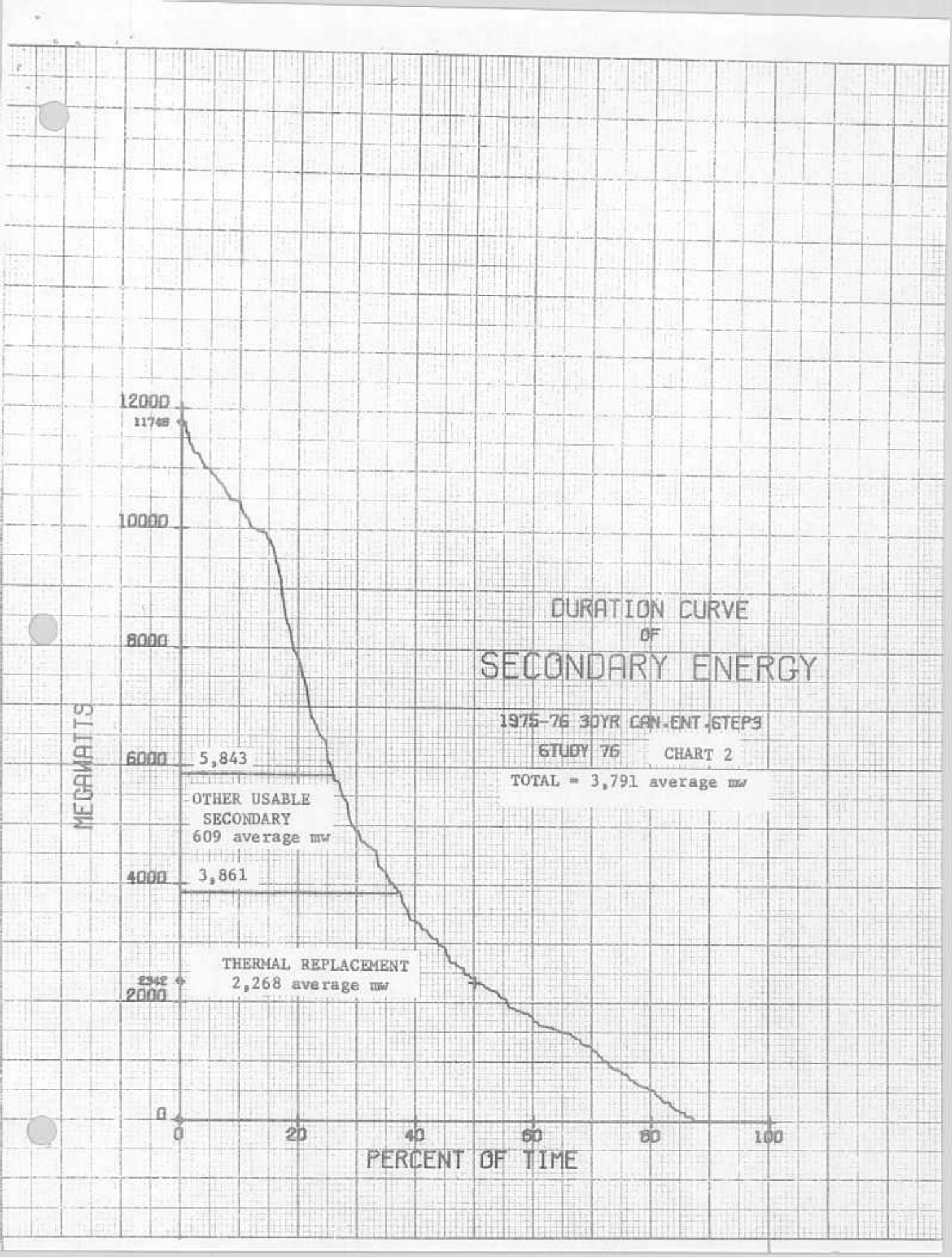
	Pacific Northwest Area Load			Step 2			Step 3		
	Peak	Avg.	Load Factor Percent	Total[1/] Firm Load	Thermal Firm Load	Hydro Firm Load	Total[1/] Firm Load	Thermal Firm Load	Hydro Firm Load
July	21,428*	15,455	72.09	11,929	3,861	8,068	9,795	3,861	5,934
Aug. 1-15	21,760*	15,543	71.43	11,997	3,861	8,136	9,850	3,861	5,989
Aug. 16-31	21,720*	15,521	71.46	11,980	3,861	8,119	9,837	3,861	5,976
Sept. 1-15	22,002*	15,413	70.05	11,896	3,861	8,035	9,768	3,861	5,907
Sept. 16-30	22,002*	15,372	69.87	11,864	3,861	8,003	9,742	3,861	5,881
October	23,025*	15,735	68.34	12,145	3,861	8,284	9,973	3,861	6,112
November	24,678*	16,743	67.85	12,923	3,861	9,062	10,611	3,861	6,750
December	25,757*	17,711	68.76	13,671	3,861	9,810	11,225	3,861	7,364
January	26,063*	18,297	70.20	14,123	3,861	10,262	11,597	3,861	7,736
February	24,978*	17,610	70.50	13,593	3,861	9,732	11,161	3,861	7,300
March	24,064*	16,914	70.29	13,055	3,861	9,194	10,720	3,861	6,859
Apr. 1-15	23,381*	16,303	69.73	12,584	3,861	8,723	10,333	3,861	6,472
Apr. 16-30	23,281*	16,305	69.74	15,585	3,861	8,724	10,334	3,861	6,473
May	23,272*	15,946	68.52	12,308	3,861	8,447	10,106	3,861	6,245
June	22,711*	16,003	70.46	12,353	3,861	8,492	10,143	3,861	6,282
Critical Period Avg.		16,517	69.782	12,824	3,861	8,963	10,759	3,861	6,898
Annual Average		16,468		12,711	3,861	8,850	10,437	3,861	6,576
January Peak	26,063*								
Step 1 Critical Period Aug. 16, 1928 - Feb. 29, 1932 42-1/2 Months				Critical Period Sept. 1943 - Apr. 1945 20 Months			Critical Period Sept. 16, 1936- Apr. 15, 1937 7 Months		

1/ Total firm load of Step 2 and Step 3 systems, computed for each system to have an average energy load equivalent to the average energy capability within the critical period and to bear a constant ratio, month by month, to the Pacific Northwest Area Load.

* Figures so marked are peak megawatts. All other figures are monthly or semi-monthly energy in average megawatts.

TABLE 3


DURATION CURVE
OF
SECONDARY ENERGY
1975-76 30YR CAN.ENT.STEP2
STUDY 76
CHART 1
TOTAL = 2,321 average mw
MEGAWATTS
12000
10000
9824
8000
6000
5,079
OTHER USABLE
SECONDARY
254 average mw
4000
3,861
2000
THERMAL REPLACEMENT
1,685 average mw
1256
0
0
20
40
60
80
100
PERCENT OF TIME


12000
11748
10000
8000
6000
5,843
OTHER USABLE
SECONDARY
609 average mw
4000
3,861
THERMAL REPLACEMENT
2,268 average mw
2342
2000
0
MEGAWATTS
0
20
40
60
80
100
PERCENT OF TIME
DURATION CURVE
OF
SECONDARY ENERGY
1975-76 30YR CAN.ENT.6TEP3
6TUDY 76 CHART 2
TOTAL = 3,791 average mw